PROJ #978415

[redacted] STAT

February 24, 1965

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Attention: [redacted]

Gentlemen:

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[redacted] is pleased to submit, for your evaluation, a cost and technical proposal for a program in the Study, Design and Manufacture of Improved Anamorphic Eyepieces. Enclosed please find our technical proposal in triplicate.

Recent investigations have been made at [redacted] in pursuit of an improved design of anamorphic eyepieces indicating a need for further study of the problem. As we feel that the proposed program would involve extending the present state-of-the-art, our proposal is submitted on a cost-plus-fixed-fee basis. Our cost analysis is included on "Attachment A". STAT

The delivery cycle of the proposed program is eleven (11) months after receipt of a fully executed contract.

If you have any questions concerning this proposal, of either a technical or contractual nature, please contact the writer directly.

Very truly yours,

[redacted] STAT

Contract Administrator
Photogrammetric Contracts Section

STAT [redacted]

Declass Review by NGA.

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Proposal for Study
Design and Manufacture
of Improved Variable Anamorphic
Eyepieces

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1.0 INTRODUCTION

In response to a recent request for eyepieces having variable anamorphic magnification, [redacted] designed a first model Variable Anamorphic Eyepiece. This instrument is comprised basically of three parts, (1) a collimator, (2) an afocal anamorphic zoom system composed of cylinder lenses, and (3) a collective lens plus conventional eyepiece. It has two basic faults. First, the image is inverted. Second, it is large and bulky. It raises the level of the eyepiece $5\frac{1}{2}$ inches, necessitating a bend in the optical train to achieve a reasonable interpupillary distance and a higher than normal chair for the operator. It is desirable to design a system which will not have these faults. STAT

Study of means of eliminating these faults has shown that no simple solution exists. The present proposed program consists of an initial study phase in which various approaches will be evaluated in terms of estimated optical performance (detailed optical design study will not be done during this phase) and mechanical configuration. On the basis of this study one system will be chosen, a complete optical mechanical design effort will be performed, and a pair of eyepieces manufactured.

2.0 TECHNICAL DISCUSSION

The Mod I Variable Anamorphic Eyepieces were designed to be used on the Zoom 70. However, there are indications that the variable anamorphic concept is useful on a variety of stereoviewers. This presents a problem since the Zoom 95, Zoom 70, and High Power StereoViewer do not all have the same mechanical clearances in the vicinity of the eyepiece. Because spatial limitations are very important in this problem, it may be that no one solution will be applicable to all stereo instruments. The following discussion will be concerned with obtaining anamorphic magnification with the Zoom 70, but the results of the study to be proposed will be very useful in devising similar instrumentation for the other stereo viewing equipment.

In the proposal which led to the development of the Mod I Variable Anamorphic Eyepieces, three methods for obtaining variable anamorphic magnifying power were discussed. Briefly, they are as follows:

(1) Tilting prisms.
(2) Zoom system of cylinder lenses.
(3) System of counter rotating cylinders.

All three have one thing in common, and that is that they operate in collimated light. The only practical collimator for these systems is a positive eyepiece type lens near the eyepiece focal plane of the Zoom 70. In order to see the image carried by the collimated light it is necessary to add to the system an objective lens to form the image. This is the source of one of our problems for the image formed by the collimator-objective combination is inverted. If a negative collimating lens could be used the image would be erect. But, the use of a negative collimator lens would result in a large loss in field coverage unless the lens could be placed far down in the Zoom 70. It would be necessary to modify the Zoom 70 to do this.

To construct a variable anamorphic system having the required erect image, one of three things must be done.

1. Construct a compact positive magnification variable anamorphic eyepiece which will work in converging light.

2. Construct a system similar to the Mod I eyepiece adding an erecting system such as a pechan prism or an erecting telescope.

3. Modify the existing zoom 70 to obtain a narrow beam of collimated light in which an anamorphic system can be placed, followed by a telescope to form an erect image.

2.1 Optical Requirements

The eyepieces can be considered as having two meridians, parallel to the axis and mutually perpendicular, one being the plane in which the magnification is varied, the other being the plane in which the magnification is fixed. Each meridian can be considered as having its own exit pupil and its own image plane. If the central image is to be free from astigmatism, the two image planes must coincide exactly. This means that when zoom systems are used only mechanically compensated zoom systems will work. Similarly if the whole field is to be seen at once the two pupils must be in reasonable coincidence. The first part of the problem is to find systems in which these two conditions are met.

While a number of systems meeting these requirements have been developed in gross concept, efforts to date to design them into a reasonable size package have been unsuccessful. This problem would be alleviated if the requirement for a collimating lens could be removed. Thus one aspect of the study phase will be a detailed examination of the deleterious effects of non-collimated light on the various configurations so far considered.

3.0 PROPOSED FEASIBILITY STUDY

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[redacted] proposes to study the feasibility of different types of systems described as follows:

3.1 <u>Cylindrical Zoom</u> (Figure 1)

Vary the anamorphic magnification of the image in the eyepiece focal plane by means of a suitable cylinder zoom system. Adjust the location of the exit pupil by means of a suitable fixed magnification cylinder relay located as shown in Figure 1, and view the image with a long focal length eye lens (say 5x).

Prior investigation of such a system has indicated that thin lens wise such a system is possible, but that the anamorphic ratio might have to be variable from something like .7 to 1.54 rather than the desired 1 to 2.2. In use this means that images would be compressed and stretched to bring them into stereo fusion rather than merely stretched as the current specifications imply.

Only one of many possible zoom systems of this type has been considered, and a search will be conducted to see if a more suitable first order configuration can be found.

3.2 <u>Cylindrical Eyepiece</u> (Figure 2)

Construct an eyepiece completely of crossed cylinders fixed in one meridian and variable in the other.

Relatively compact zoom systems exist in which the object is an aerial image and the image is vertical and formed at a considerable distance from the object. In other words the zoom system works as a variable power eyepiece. It may be possible to construct such a zoom system of cylinder lenses and intersperse among or around the cylinder lenses other fixed cylinder lens oriented at 90° to the zoom system in such a way that the net effect will be in one case that of an eyepiece composed of spherical lenses. Inasmuch as crossed cylinders must be used in System 1, System 2 would be no more complicated and might prove to have a more favorable range of anamorphic ratios. It also might prove to be a shorter system.

3.3 Prism Anamorphism (Figure 3)

Vary the anamorphic ratio of the eyepiece focal plane image by means of a prism anamorphic system and view this image with a suitable eyepiece lens.

At first glance, since no collimating lens is used this method apeears impossible because this eyepiece must work in converging light, and prism systems of this sort work only in collimated light. However, it may be possible to back the prism system up with a weak cylinder system to correct the aberrations introduced by the prisms.

The prism system has one advantage over the cylinder lens system which should not be over looked and this is that the alignment of prism systems is not nearly as critical as the alignment of cylinder systems, therefore, unless cylinder systems offer some distinct advantage over prism systems (e.g. a shorter overall length) prism systems are preferable.

3.4 Folded System (Figure 4)

Build a device similar to the current variable anamorphic eyepieces consisting of a collimator, a plano mirror, a zoom cylinder system, a telescope objective which combined with the collimator will make a unit power relay, an image rotation device such as a pechan prism, and an eyepiece.

The length of this arrangement is prohibitive if it is run straight up from the eyepiece mount. To eliminate this problem the unit would be bent with a mirror to extend over the power pod of the stereoscope. Two configurations are possible. The first is a single bend over the pod necessitating turning the stereoscope 180° for use. The second has an initial bend over the pod and is then again folded back so that the viewing end of the unit is approximately in the normal position.

Either approach would result in a unit too heavy to be supported by the eyepiece tube and design for additional support from the top of the pod will be necessary. In doing this access to the stereozoom controls must be maintained.

This approach has the advantage that the current zoom system could be used. Its success will depend on whether the space required for folding and for components to erect the image can be obtained without excessive loss of field.

3.5 Prism Modification (Figure 5)

In the system described in 3.4 overall length need not be constrained as much as it was in the first version of the variable anamorphic eyepiece. Therefore, a system of four tilting prisms introducing an anamorphic range of 5:1 to 1.5:1 or combined with a cylinder systemed to give a range 1:1 to 3:1 might be possible.

Essentially the same as described in Section 3.4 this system takes advantage of the less critical alignment requirements of the prism method of achieving anamorphism.

4.0 WORK STATEMENT

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[redacted] will conduct a study of the various types of anamorphic eyepiece systems described in Section 3. On the basis of this study the best system will be selected. This best system will then be carried through final design and a pair of eyepieces manufactured to this design.

Monthly progress reports will be furnished. At the end of the study phase a report summarizing the results of the study will be submitted.

Design goals for the New Variable Anamorphic Eyepieces will be as follows:

1. Basic eyepiece magnification of 5x and/or 10x with variable anamorphic ratio from 1:1 to 1:2.2 (more if possible). Anamorphic ratios of less than 1 will be considered.

2. The maximum acceptable loss of field will be 15%.

3. Anamorphic direction will be adjustable through 360°.

4. The loss in resolving power on axis will be no more than 20% as compared with a normal eyepiece of comparable magnifying power. Every effort will be made

to improve off axis image performance.

5. The new Variable Anamorphic Eyepieces will not increase the height of the eyepoint more than 4 inches above the normal eyepoint position for the Zoom 70.

5.0 PROGRAM SCHEDULE

The time required for completion of the program described in Section 4. will be as follows:

Preliminary design study	3 months
Final design	4 months
Manufacture	4 months

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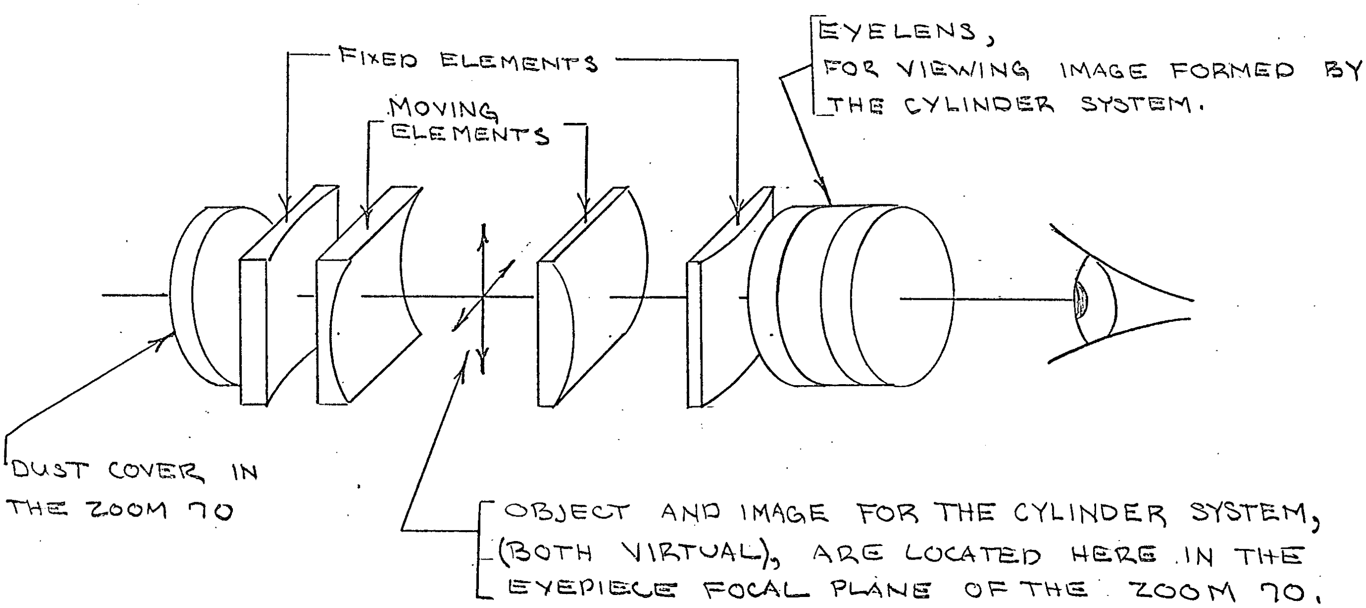

FIGURE 1 CYLINDRICAL ZOOM

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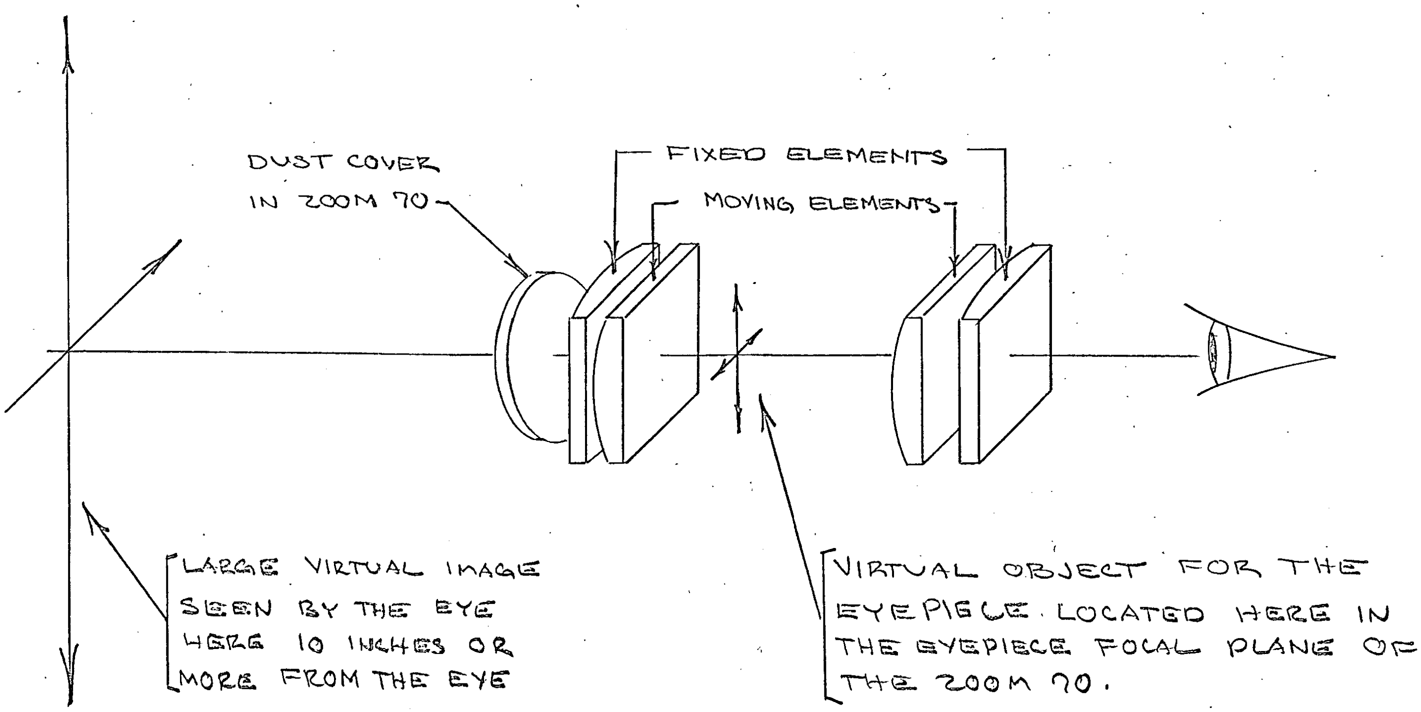

FIGURE 2 CYLINDRICAL EYEPIECE

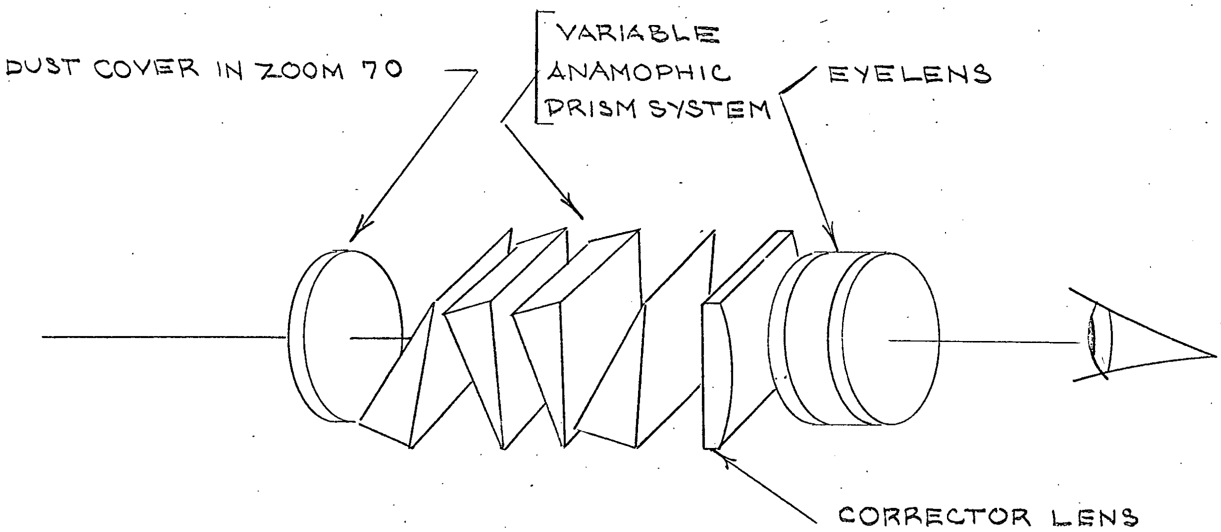

FIGURE 3 PRISM ANAMORPHISM

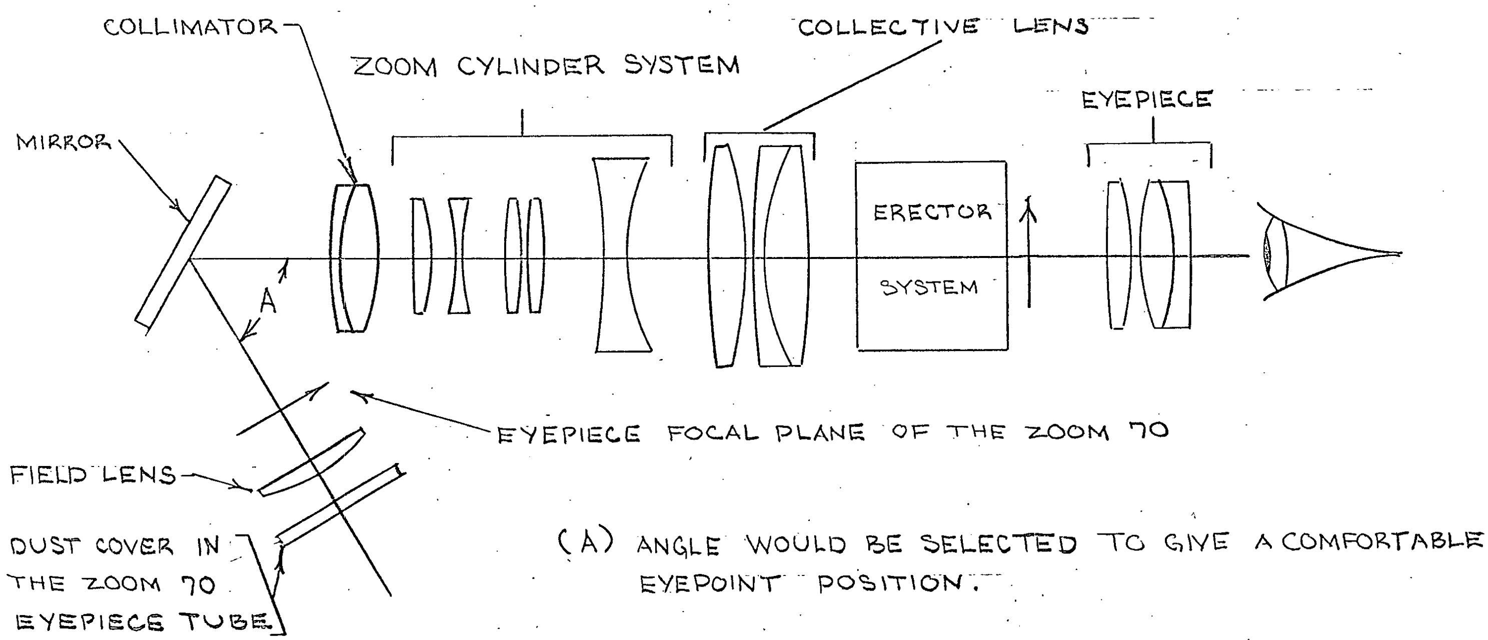

FIGURE 4 FOLDED SYSTEM

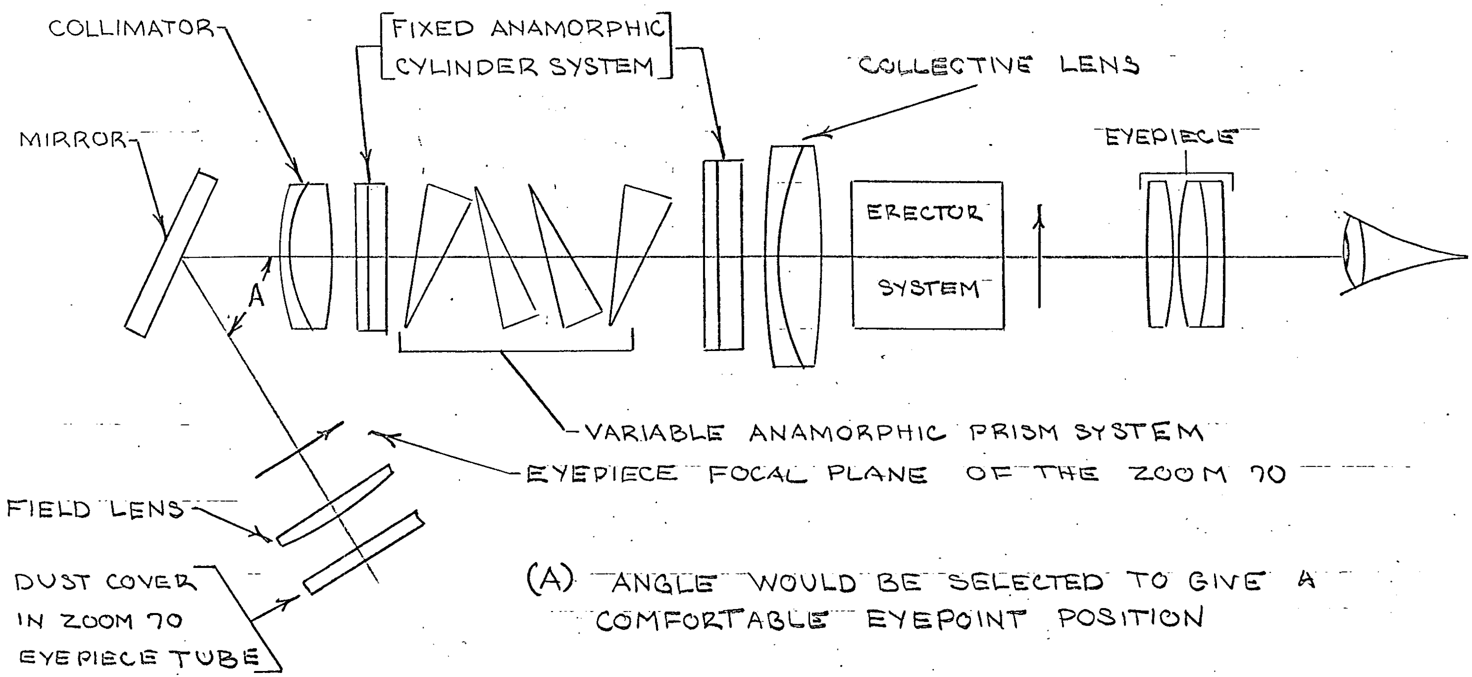

FIGURE 5 PRISM MODIFICATION OF THE FOLDED SYSTEM